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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Katsumasa Yoshii et al.

Serial No. To Be Assigned

Filing Date: Herewith

For: Reflector Providing Particularly High Reflectance in an Intended Viewing Angle and Reflection Type Liquid Crystal Display Device Using the Same

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to examination of the above-identified application, please amend the application as follows:

In the Specification

Please rewrite the paragraph beginning on page 3, line 26 and ending on page 4, line 5 as follows:

(Amended) The conventional reflector 71 described above enables one to obtain relatively good reflectance over a relatively wide angle due to the concave portions. However, as β shown in the comparative example of FIG. 7 or FIG. 12, the relatively higher reflection intensity peaks at the reflection angles 15° and 45°, which appear symmetrical with the reflection angle 30° being an axis of symmetry.

Please rewrite the paragraph beginning on page 4, line 22 and ending on page 5, line 4 as follows:

(Amended) As seen in FIG. 17, directions in which a user usually looks at the display device 83 are concentrated in a range of the direction of the reflection light R_2

near the normal line P as opposed to a range of the reflection light R_3 in which the user has to look up at the display device 83 from a lower direction making it more difficult to see it. Therefore, for convenience of the users, it is desirable to secure a wide viewing angle while enhancing reflectance in the direction in which the reflection angle is smaller than reflection light.

Please rewrite the paragraph beginning on page 9, line 23 and ending on page 10, line 5 as follows:

(Amended) If each of the concave portions is arranged apart from each other, an opening between each of the concave portions becomes a flat surface, thus increasing the flat surface reflection, and therefore, it would become harder to obtain sufficient diffuse reflection within a limited pixel range. Thus, it is preferable that each of the concave portions is arranged adjacent to each other. Moreover, if the concave portions were arranged regularly, the moiré pattern would generate. Therefore, it is preferable to arrange them randomly.

Please rewrite the paragraph on page 13, lines 12-23 as follows:

(Amended) In addition, each of the concave portions is desirably formed randomly with depth in a range of 0.1 μm to 3 μm. In a case where the depth is less than 0.1 μm, regular reflection becomes too strong. In a case where the depth exceeds 3 μm, surfaces of convex portions cannot be filled with a smoothing film when concave portions are evened out in a later process, and it becomes impossible to obtain desirable reflection property. If the depth is set to a certain depth for all the concave portions, interference color of light would generate due to regularity, and a problem of coloring of the reflection light would occur.

Please rewrite the paragraph on page 15, lines 7-13 as follows:

(Amended) The liquid crystal display device of the present invention is provided with a wide viewing angle and suitable directionality. Therefore, when it is incorporated in certain devices such as a notebook personal computer, a game machine and a cellular phone, it is possible to obtain sufficient brightness in the viewing angle which users typically view the device.

Please rewrite the paragraph on page 19, lines 22-27 as follows:

(Amended) In the reflector in Embodiment 1 of the present invention, each of the concave portions is formed in non-spherical shape having a single minimal point. Therefore, a reflection angle of light changes smoothly so that reflection light does not produce glare in a particular viewing angle.

Please rewrite the paragraph on page 22, lines 19-24 as follows:

(Amended) Moreover, the transparent electrodes 16 and 23 interposing the liquid crystal layer 30 therebetween are formed in stripe pattern on a surface which cross perpendicular to each other so as to form a simple matrix display device in which intersecting areas of the stripes are pixel thereof.

Please rewrite the paragraph beginning on page 28, line 20 and ending on page 29, line 8 as follows:

(Amended) The reflector having the above-described composition can be formed as follows though not limited thereto. First, as shown in FIG. 10A, a mold base material 37 of a flat plate having a flat surface made of a brass, a stainless steel, a tool steel or the like, for example, is fixed on a table of a rolling device. Then, the surface of the mold base material 37 is pressed by a diamond indenter 38 whose tip is in the particular shape corresponding to the concave portions 34 shown in FIG. 9. The diamond indenter 38 is moved up and down and pressed against the mold base material 37 while the mold base material 37 is moved in a horizontal direction. By repeating this operation for a number of times, the plurality of concave portions 37a with different depths and different pitches are formed on the surface of the mold base material 37, thus obtaining a mold 39 for forming a reflector shown in FIG. 10B.

Please rewrite the paragraph beginning on page 35, line 15 and ending on page 36, line 1 as follows:

(Amended) As shown in FIG. 14, the reflection type liquid crystal display device includes a pair of substrate, a display side glass substrate 53 and a back-side glass substrate 54 with a thickness of 0.7 mm, for example, and a liquid crystal layer 55 interposed therebetween. A phase plate 56 made of polycarbonate resin, polyarylate resin or the like is provided on a top surface of the display side glass substrate 53. A first polarizing plate 57 is provided on a top surface side of the

phase plate 56. On a lower side of the back-side glass substrate 54, a second polarizing plate 58 and the reflector 31 according to a preferred embodiment of the present invention shown in FIG. 14 are provided in that order.

In the Claims

Please rewrite Claim 10 as follows:

10. (Amended) A reflector, comprising: a plurality of concave portions formed on a reflector surface, an inner surface of each of the concave portions including a bottom curved surface and a peripheral curved surface, the peripheral curved surface being a part of a first sphere having a first radius, the bottom curved surface being a second sphere having a second radius different from the first radius, and the bottom curved surface being located within the peripheral curved surface, wherein the first radius is smaller than the second radius, and a normal line extending from a center of the first sphere to the reflector surface and a normal line extending from a center of the second sphere to the reflector surface are not collinear.

Please rewrite Claim 13 as follows:

13. (Amended) The reflector according to claim 10, wherein the plurality of concave portions are formed randomly with the depth thereof ranging from 0.1 μm to 3 μm.

Please rewrite Claim 14 as follows:

14. (Amended) The reflector according to claim 10, wherein the plurality of concave portions are formed so that they are continuously connected to each other.

Please rewrite Claim 15 as follows:

15. (Amended) The reflector according to claim 10, wherein the plurality of concave portions are formed along with many grooves on the reflector surface.

In the Abstract of the Disclosure

Please rewrite the Abstract of the Disclosure as follows:

(Amended) ABSTRACT OF THE DISCLOSURE

A reflector and reflector-type LCD suppresses inter-object reflection over a wide angle, and provides particularly high reflectance in an intended range of viewing angle. The reflector includes a plurality of concave portions with an

inclination angle (an angle between a plane tangential to a point on a concave surface and the surface of the base material) that is maximum on a side portion of the curved surface. The concave portions may also be formed such that an inner surface of each of the concave portions include a peripheral curved surface and a bottom curved surface are continuously connected to each other. The peripheral curved surface and the bottom curved surface are interposed partial spheres having different radii and non-collinear normal lines from the surface of each sphere.

REMARKS

Applicant has rewritten portions of the specification, Claims 10 and 13-15 and the Abstract of the Disclosure. The changes from the previous version to the rewritten version are shown in attached Appendix A, with strikethrough for deleted matter and underlines for added matter.

Respectfully submitted,

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APPENDIX A
Attorney Docket No. 9281-4130
Reflector Providing Particularly High Reflectance in an Intended Viewing Angle and Reflection Type Liquid Crystal Display Device Using the Same
Katsumasa Yoshii et al.

In the Specification

Please amend the paragraph beginning on page 3, line 26 and ending on page 4, line 5 as follows:

(Amended) The conventional reflector 71 described above enables one to obtain relatively good reflectance over a relatively wide angle due to the concave portions. However, as β shown in the comparative example of FIG. 7 or FIG. 12, the relatively higher reflection intensity peaks at the reflection angles 15° and 45°, which appear symmetrical with the reflection angle 30° being an axis of symmetry.

Please amend the paragraph beginning on page 4, line 22 and ending on page 5, line 4 as follows:

(Amended) As seen in FIG. 17, directions in which a user usually looks at the display device 83 are concentrated in a range of the direction of the reflection light R_2 near the normal line P as opposed to a range of the reflection light R_3 in which the user has to look up at the display device 83 from a lower direction making it more difficult to see it. Therefore, for convenience of the users, it is desirable to secure a wide viewing angle while enhancing reflectance in the direction in which the reflection angle is smaller than reflection light.

Please amend the paragraph beginning on page 9, line 23 and ending on page 10, line 5 as follows:

(Amended) If each of the concave portions is arranged apart from each other, an opening between each of the concave portions becomes a flat surface, thus increasing the flat surface reflection, and therefore, it would become harder to obtain sufficient diffuse reflection within a limited pixel range. Thus, it is preferable that each of the concave portions is arranged adjacent to each other. Moreover, if the concave portions were arranged regularly, the moiré pattern would generate. Therefore, it is preferable to arrange them randomly.

Please amend the paragraph on page 13, lines 12-23 as follows:

(Amended) In addition, each of the concave portions is desirably formed randomly with depth in a range of 0.1 μm to 3 μm. In a case where the depth is less than 0.1 μm, regular reflection becomes too strong. In a case where the depth exceeds 3 μm, surfaces of convex portions cannot be filled with a smoothing film when concave portions are evened out in a later process, and it becomes impossible to obtain desirable reflection property. If the depth is set to a certain depth for all the concave portions, interference color of light would generate due to regularity, and a problem of coloring of the reflection light would occur.

Please amend the paragraph on page 15, lines 7-13 as follows:

(Amended) The liquid crystal display device of the present invention is provided with a wide viewing angle and suitable directionality. Therefore, when it is incorporated in certain devices such as a notebook personal computer, a game machine and a cellular phone, it is possible to obtain sufficient brightness in the viewing angle which users typically views the device.

Please amend the paragraph on page 19, lines 22-27 as follows:

(Amended) In the reflector in Embodiment 1 of the present invention, each of the concave portions is formed in non-spherical shape having a single minimal point. Therefore, a reflection angle of light changes smoothly so that reflection light does not ~~become~~produce glare in a particular viewing angle.

Please amend the paragraph on page 22, lines 19-24 as follows:

(Amended) Moreover, the transparent electrodes 16 and 23 interposing the liquid crystal layer ~~2330~~ therebetween are formed in stripe pattern on a surface which cross perpendicular to each other so as to form a simple matrix display device in which intersecting areas of the stripes are pixel thereof.

Please amend the paragraph beginning on page 28, line 20 and ending on page 29, line 8 as follows:

(Amended) The reflector having the above-described composition can be formed as follows though not limited thereto. First, as shown in FIG. 10A, a mold base material 37 of a flat plate having a flat surface made of a brass, a stainless steel, a tool steel or the like, for example, is fixed on a table of a rolling device.

Then, the surface of the mold base material 37 is pressed by a diamond indenter 38 whose tip is in the particular shape corresponding to the concave portions 34 shown in FIG. 9. The diamond indenter 38 is moved up and down and pressed against the mold base material 37 while the mold base material 37 is moved in a horizontal direction. By repeating this operation for a number of times, the plurality of concave portions 37a with different depths and different pitches are formed on the surface of the mold base material 37, thus obtaining a mold 39 for forming a reflector shown in FIG. 10B.

Please amend the paragraph beginning on page 35, line 15 and ending on page 36, line 1 as follows:

(Amended) As shown in FIG. 14, the reflection type liquid crystal display device includes a pair of substrate, a display side glass substrate 53 and a back-side glass substrate 54 with a thickness of 0.7 mm, for example, and a liquid crystal layer 55 interposed therebetween. A phase plate 56 made of polycarbonate resin, polyarylate resin or the like is provided on a top surface of the display side glass substrate 53. A first polarizing plate 57 is provided on a top surface side of the phase plate 56. On a lower side of the back-side glass substrate 54, a second polarizing plate 58 and the reflector 31 according to a preferred embodiment of the present invention shown in FIG. ~~8~~14 are provided in that order.

In the Claims

Please amend Claim 10 as follows:

10. (Amended) A reflector, comprising: ~~many~~a plurality of concave portions formed on a reflector surface, an inner surface of each of the concave portions including a bottom curved surface and a peripheral curved surface, the peripheral curved surface being a part of a first sphere having a first radius, the bottom curved surface being a second sphere having a second radius different from the first radius, and the bottom curved surface being located within the peripheral curved surface, wherein the first radius is smaller than the second radius, and a normal line extending from a center of the first sphere to the reflector surface and a normal line extending from a center of the second sphere to the reflector surface are not collinear.

Please amend Claim 13 as follows:

13. (Amended) The reflector according to claim 10, wherein the ~~many~~plurality of concave portions are formed randomly with the depth thereof ranging from 0.1 μm to 3 μm.

Please amend Claim 14 as follows:

14. (Amended) The reflector according to claim 10, wherein the ~~many~~plurality of concave portions are formed so that they are continuously connected to each other.

Please amend Claim 15 as follows:

15. (Amended) The reflector according to claim 10, wherein the ~~many~~plurality of concave portions are formed along with many grooves on the reflector surface.

In the Abstract of the Disclosure

Please amend the Abstract of the Disclosure as follows:

(Amended) ABSTRACT OF THE DISCLOSURE

~~The present invention provides a~~A reflector and reflector-type LCD ~~having a light-diffusing property which~~ suppresses inter-object reflection over a wide angle, and ~~giving~~provides particularly high reflectance in an intended range of viewing angle~~; and to provide a reflection type liquid crystal display device using the same~~. The reflector includes a plurality of ~~light-reflective~~ concave portions~~. Each of the concave portions is formed so that~~ with an inclination angle (an angle between a plane tangential to a point on a concave surface and the surface of the base material) that is maximum on a side portion of the curved surface~~, and so that the direction of the side portion having the maximum inclination angle is on a far side from a view point of an observer~~. ~~Moreover, the reflector includes many~~The concave portions may also be formed ~~on a reflector surface,~~such that an inner surface of each of the concave portions ~~including~~include a peripheral curved surface and a bottom curved surface ~~that~~ are continuously connected to each other~~.~~, tThe peripheral curved surface and the bottom curved surface are interposed partial spheres having different radii and non-collinear normal lines from the surface of each sphere.~~being a part of a first sphere having a first radius, the bottom curved surface being a part of a second sphere having a second radius different from the first~~

radius, and the bottom curved surface being located within the peripheral curved surface, wherein the first radius is smaller than the second radius, and a normal line extending from a center of the first sphere to the reflector surface and a normal line extending from a center of the second sphere to the reflector surface are not collinear. Further, the reflection type liquid crystal display device is provided with the reflector.